

## **REMARKS**

### ***Preliminary Remarks***

Reconsideration and allowance of this application are respectfully requested. Claims 1-10, 12-48 and 50-51 are pending and stand rejected in this application.

Independent claims 1, 2, 22, 34 and 43 have been amended. Support for the Amendment is provided in the specification. No new matter has been introduced. Claims 11, 49 and 52-59 have been canceled.

### ***Response To Claim or Rejections Under 35 U.S.C. § 112***

Claims 11, 12 and 22-33 stand rejected under 35 U.S.C. § 112, for reasons previously expressed in Paper No. 7, pages 2-3, paragraph 4. The Examiner asserts that the claims are indefinite for failing to particularly point out and distinctly claim the subject matter which applicant regards as the invention. Specifically, Claims 11 and 12 set forth a ratio of organic solvent to water but fails to define the units of said ratio. Applicants respectfully disagree with this rejection. A ratio by definition does not contain a unit.

Claims 22-33 stand rejected Under 35 U.S.C. § 112 as indefinite. Specifically the Examiner asserts the claims are indefinite because it is unclear whether the particles referred to as having a diameter of 10 nm to 100 nm are dry particles, sol particles or gel particles. The Amendment to Claim 22 specifying the particle as in a solution render moot these rejections and Applicants respectfully request withdrawal of these rejections.

### ***Response To Rejection Under 35 U.S.C. § 102(b)***

The Examiner rejects Claims 1-3, 7-20, 22-23, 25-35, 37-44 and 46-51. Under 35 U.S.C. § 102(b) as being anticipated by M.Z.C. Hu et al., "Nucleation and Growth for Synthesis of Nanometric Zirconia Particles by Forced Hydrolysis", J. of Colloid and Interface Science, 198:87-99 (1998) (hereinafter "Hu"). The Examiner

alleges that the above-referenced article discloses methods of making nanoparticles by mixed solvent nucleation and growth of zirconia particles. Applicants respectfully traverse.

Applicants respectfully assert that Hu does not anticipate Applicants' invention as claimed. Hu's article is clearly different from Applicants' invention as claimed since Hu discloses forming nanosized, **cube-shaped** monoclinic zirconia particles via thermal incubation at **elevated temperatures** (95 to 120°C) which induces **forced hydrolysis** and condensation of zirconium tetramer. The forced hydrolysis process disclosed by Hu is **slow** in producing particles. Further, the forced hydrolysis process takes a few days for the complete conversion from soluble zirconium species to solid nanoparticles (See Table 1). Further, Hu discloses using 0.4/1 to 1/1 ratio of isopropanol to water.

In contrast, Applicants' invention as claimed is not directed to forming cube-shaped nanosized zirconia particles at elevated temperatures via forced hydrolysis. Rather Applicants' claimed invention discloses producing **sphere particle shapes** by utilizing **lower temperatures** and higher organic solvent to water ratios. Hu utilizes higher temperatures to control particle growth. Compare Figures 5 and 6 in Hu which illustrate that at room temperature the particle size grew to over 500 nm within 5 minutes however at higher temperatures the particles remained under 300 nm over 25 hours. Comparatively Applicant's claimed invention utilizes lower temperatures and higher organic solvent to water ratios while still being able to control particle growth. The process of Applicants' invention causes **homogenous precipitation** due to the creation of supersaturation in low dielectric medium **rather than forced hydrolysis** as disclosed in Hu. The sol-gel process refers to homogenous nucleation and growth of a polymer in a liquid medium which forms a uniform powder or gel after drying. The claimed method is unique in sol-gel coating applications with inorganic metal salt precursors. Further, the incubation time of the Applicant's invention is much shorter than the incubation time disclosed in Hu. (See Table 1, Page 7).

Since Hu's article is fundamentally different from Applicants' invention, as claimed, Applicants respectfully assert that a rejection under 35 U.S.C. § 102(b) has

been overcome and requests withdrawal of the rejection.

***Response to Rejection Under 35 U.S.C. § 102(b)***

The Examiner rejects Claims 1-5, 7-21 and 34-51, as being anticipated by Y.T. Moon et al., "Preparation of Monodispersed and Spherical Zirconia Powders by Heating of Alcohol-Aqueous Salt Solutions", J. Am. Ceram. Soc., 78(10): 2690-2694 (1995) (hereinafter "Moon"). The Examiner alleges that the above-referenced article discloses methods of making monodispersed  $ZrO_2$  from zirconyl chloride solutions. Applicants respectfully traverse.

Applicants respectfully assert that Moon does not anticipate Applicants' invention as claimed. Moon's article is clearly different from Applicants' invention as claimed since Moon discloses producing a monodispersed, spherical zirconia **powder** via microwave heating. (See Table 1). Moon's article discloses that in order to produce non-agglomerated spherical particles microwave heating **must be utilized**. (See Figures 1-4). Further, Moon **does not teach or suggest sol-gel processing** in inorganic metal salt solutions which are useful as precursors in various technologies, such as the coating industry. Moon does not address the particle connectivity that is present in a porous gel network, particle morphology or particle hardness as does the sol-gel processing of the claimed invention. See Examples.

In contrast Applicants' claimed invention is not limited to powder formation, rather Applicant's invention is directed to **producing a sol or a gel** containing dispersed particles which are useful in coatings and films. The **claimed method is unique** in sol-gel coating applications with inorganic metal salt precursors. See Example 10 illustrating the capability of the methods of achieving sol and gel processing in inorganic metal salt solutions of mixed alcohol-water solvent. Applicants' claimed invention also utilizes different solvents than are disclosed in Moon. The product produced from the claimed product can be a sol or a gel and therefore is more polymeric than the powder produced by Moon. Further, Applicants claimed invention does not utilize microwave heating at high temperatures.

Since Moon's article is fundamentally different from Applicants'

invention, as claimed. Applicants respectfully assert that a rejection under 35 U.S.C. § 102(b) has been overcome and requests withdrawal of the rejection.

***Response to Rejection Under 35 U.S.C. § 103(a)***

The Examiner rejects Claims 1-51 under 35 U.S.C. § 103(a) as being unpatentable over the article Y.T. Moon et al., "Preparation of Monodispersed and Spherical Zirconia Powders by Heating of Alcohol-Aqueous Salt Solutions", J. Am. Ceram. Soc., 78(10): 2690-2694 (1995) (hereinafter Moon). The Examiner asserts that "Moon discloses that the dispersant is absorbed on the particles during particle growth. It is concluded the dispersant is added prior to or during incubation and would be absorbed at any time prior to the conclusion of particle growth which would inhibit or stop particle growth and therefore incubation. It would have been obvious to one of ordinary skill in the art at the time of applicants invention to add the dispersant after the conclusion of the incubation since it inhibits the further growth of particles. Moon differs from Claims 22-33 in the particle size of the material produced. Moon teaches the particle growth is controlled by the dielectric properties via temperature, solvent volume ratio and would be expected to be advantageous for the increased surface area associated with smaller sized particles. Merely modifying the process conditions such as temperature and concentration is not a patentable modification absent a showing of criticality." Applicants respectfully traverse.

Applicants' respectfully assert that Moon does not anticipate or render obvious Applicants' claimed invention. Moons' article is clearly different from Applicant's invention as claimed since Moon discloses producing a **powder** via **microwave heating** and by utilizing a **different organic solvent** than used by Applicants. The process disclosed by Moon does not suggest that a **sol or gel could be produced** utilizing the powder. As discussed, Moon does not address the particle connectivity that is present in a porous gel network, particle morphology or particle hardness as does the sol-gel processing of the claimed invention. See Examples.

In contrast Applicants' claimed invention is not limited to powder formation, rather Applicant's invention is **directed to producing a sol or a gel** which is

useful in coatings and films. The **claimed method is unique** in sol-gel coating applications with inorganic metal salt precursors. See Example 10 illustrating the capability of the methods of achieving sol and gel processing in inorganic metal salt solutions of mixed alcohol-water solvent. Applicants' claimed invention also utilizes different solvents than are disclosed in Moon, for example Moon only discloses utilizing 2-propanol as the organic solvent. The product produced from the claimed invention can be a **sol or a gel and therefore is more polymeric** than the powder produced by Moon. Further, Applicants claimed invention does not utilize microwave heating at high temperatures.

Since Moon's article is fundamentally different from Applicants' invention, as claimed, Applicants respectfully assert that a rejection under either 35 U.S.C. §§ 102(b) or 103 has been overcome and requests withdrawal of the rejection.

***Claim Amendments Versions and Markings To Show Changes Made***

In accordance with 37 CFR 1.1219(c), the following versions of the claims as rewritten by the foregoing amendment show all the changes made relative to the previous versions of the claims.

1. A method of sol-gel processing using an inorganic metal salt and a mixed solvent system, comprising:

preparing a solution including an inorganic metal salt, water, and an organic solvent having a metal salt concentration and a ratio of organic solvent to water; [and]

incubating the solution at a temperature less than 90°C for a period of time;

wherein the metal salt concentration, ratio of organic solvent to water, temperature, and time are selected to provide a sol or a gel having desired characteristics[.];

wherein the ratio of organic solvent to water ranges from about 1/1 to about 10/1;

and

wherein nanosize particles are produced.

2. The method of claim 1, wherein the step of preparing the solution comprises:

providing an aqueous solution of an inorganic metal salt;

providing an organic solvent; and

mixing the inorganic metal salt solution and the organic solvent in proportions so that the desired metal salt concentration and the desired ratio of organic solvent to water are achieved.

3. The method of claim 1, further comprising the step of neutralizing the solution after the incubation.

4. The method of claim 1, further comprising the step of adding a dispersant to the solution.

5. The method of claim 4, wherein the dispersant is added prior to the incubation.

6. The method of claim 4, wherein the dispersant is added after the incubation.

7. The method of claim 1, wherein the inorganic metal salt contains a metal selected from the group consisting of aluminum, hafnium, silicon, zirconium, titanium, lanthanum, germanium, tantalum, and combinations thereof.

8. The method of claim 1, wherein the organic solvent is selected from the group consisting of methanol, ethanol, isopropanol, n-propanol, tert butyl alcohol, n-butanol, acetone, and glycerol.

9. The method of claim 1, wherein the concentration of inorganic metal salt ranges from about 0.005 M to about 0.5 M

10. The method of claim 9, wherein the concentration of inorganic metal salt ranges from about 0.025 M to about 0.2M.

Claim 11 has been cancelled.

12. The method of claim [11] 1, wherein the ratio of organic solvent to water ranges from about [0.5/1] 1/1 to about 5/1.

13. The method of claim 1, wherein the temperature ranges from about 20 °C to about [150]90°C.

14. The method of claim 13, wherein the temperature ranges from about 22 °C to about [120]90 °C.

15. The method of claim 1, wherein the time ranges from about one minute to about 72 hours.



16. The method of claim 1, wherein a sol is produced.
17. The method of claim 1, wherein the ratio of organic solvent to water ranges from about [0.1]1/1 to 2/1 and a gel is produced.
18. The method of claim 1, wherein monodispersed particles are produced.
19. The method of claim 1 wherein the temperature ranges from about 20 °C to about 25 °C and wherein nanosize particles are produced.
20. The method of claim 1 wherein the temperature ranges from about 20 °C to about 25 °C and wherein monodispersed particles are produced.
21. The method of claim 4, wherein the concentration of dispersant ranges from above zero to about  $10^{-2}$  g/cm<sup>3</sup>.
22. A method of producing nanosize particles using an inorganic metal salt and a mixed solvent system, comprising:  
  
preparing a solution including an inorganic metal salt, water, and an organic solvent having a metal salt concentration and a ratio of organic solvent to water; [and]  
  
incubating the mixture at a temperature less than 90°C or a period of time;

wherein the metal salt concentration, ratio of organic solvent to water, temperature, and time have been manipulated to provide primary particles in the solution having a diameter of about 10 nm to about 100 nm [.]; and  
wherein the ratio of organic solvent to water ranges from about 1/1 to about 10/1.

23. The method of claim 22, further comprising the step of neutralizing the solution after the incubation.

24. The method of claim 22, further comprising the step of adding a dispersant to the solution.

25. The method of claim 22, wherein the inorganic metal salt contains a metal selected from the group consisting of aluminum, hafnium, silicon, zirconium, titanium, lanthanum, germanium, tantalum, and combinations thereof.

26. The method of claim 22, wherein the organic solvent is selected from the group consisting of methanol, ethanol, isopropanol, n-propanol, tert butyl alcohol, n-butanol, acetone, and glycerol.

27. The method of claim 22, wherein the concentration of inorganic metal salt ranges from about 0.005 M to about 0.5 M

28. The method of claim 27, wherein the concentration of inorganic metal salt ranges from about 0.005 M to about 0.05 M

29. The method of claim 22, wherein the ratio of organic solvent to water ranges from about [0.]1/1 to about 10/1.

30. The method of claim 29, wherein the ratio of organic solvent to water ranges from about 2/1 to about 10/1.

31. The method of claim 22, wherein the temperature ranges from about 20 °C to about [150] 90 °C.

32. The method of claim 31, wherein the temperature ranges from about 22 °C to about [120] 90 °C.

33. The method of claim 22, wherein the time ranges from about one minute to about 72 hours.

34. A method of producing a sol from an inorganic metal salt at room temperature comprising:

preparing a solution including an inorganic metal salt, water, and an organic solvent having a metal salt concentration and a ratio of organic solvent to water; [and]

incubating the solution at room temperature for a period of time;  
wherein the metal salt concentration, ratio of organic solvent to water,  
and time are selected to provide a sol having desired characteristics[.];  
wherein the ratio of organic solvent to water ranges from about 1/1 to about 10/1;  
and  
wherein the sol contains nanosize particles.

35. The method of claim 34, further comprising the step of neutralizing the solution after the incubation.

36. The method of claim 34, further comprising the step of adding a dispersant to the solution.

37. The method of claim 34, wherein the inorganic metal salt contains a metal selected from the group consisting of aluminum, hafnium, silicon, zirconium, titanium, lanthanum, germanium, tantalum, and combinations thereof.

38. The method of claim 34, wherein the organic solvent is selected from the group consisting of methanol, ethanol, isopropanol, n-propanol, tert butyl alcohol, n-butanol, acetone, and glycerol.

39. The method of claim 34, wherein the concentration of inorganic metal salt ranges from about 0.005 M to about 0.5 M

40. The method of claim 34, wherein the ratio of organic solvent to water ranges from about [0.]1/1 to about 10/1

41. The method of claim 34, wherein the temperature ranges from about 20 °C to about 25 °C.

42. The method of claim 34, further comprising drying the sol to produce a particle powder.

43. A method of producing monodisperse particles at room temperature, comprising:

preparing a solution including an inorganic metal salt, water, and an organic solvent having a metal salt concentration and a ratio of organic solvent to water;

incubating the solution at room temperature for a period of time;

wherein the metal salt concentration, ratio of organic solvent to water, and time are selected to provide a sol having desired characteristics; [and]

wherein drying the sol to produce a powder of monodisperse particles[.]; and

wherein the ratio of organic solvent to water ranges from about 1/1 to about 10 1.

44. The method of claim 43, further comprising the step of neutralizing the solution after the incubation.

45. The method of claim 43, further comprising the step of adding a dispersant to the solution.

46. The method of claim 43, wherein the inorganic metal salt contains a metal selected from the group consisting of aluminum, hafnium, silicon, zirconium, titanium, lanthanum, germanium, tantalum, and combinations thereof.

47. The method of claim 43, wherein the organic solvent is selected from the group consisting of methanol, ethanol, isopropanol, n-propanol, tert butyl alcohol, n-butanol, acetone, and glycerol.

48. The method of claim 43, wherein the concentration of inorganic metal salt ranges from about 0.005 M to about 0.5 M.

Claim 49 has been cancelled.

50. The method of claim [49] 43, wherein the ratio of organic solvent to water ranges from about [4]5/1 to 10/1.

51. The method of claim 43, wherein the temperature ranges from about 20 °C to about 25 °C.

Claim 52 has been cancelled.

Claim 53 has been cancelled.

Claim 54 has been cancelled.

Claim 55 has been cancelled.

Claim 56 has been cancelled.

Claim 57 has been cancelled.

Claim 58 has been cancelled.

Claim 59 has been cancelled.

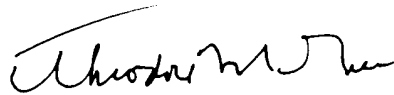
### **CONCLUSION**

In view of the above, Applicants respectfully assert that the rejections have been overcome. Applicants further assert that the claim amendments have placed all claims in condition for allowance and request that a timely notice of allowance be issued. If issues may be resolved through Examiner's Amendment or clarified in any manner, a call to the undersigned agent at (404) 532-6907 is respectfully requested.

### **AUTHORIZATIONS**

The Assistant Commissioner is hereby authorized to charge any additional fees which may be required for this Response, including all fees pursuant to 37 CFR § 1.17 for its timely consideration, or credit any overpayment to Deposit Account Number 11-0855.

Respectfully submitted,



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